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ABSTRACT

The Zimbabwe Secondary School Science Project (ZIM-SCI) developed student study guides, corresponding teaching guides, and science kits for a low-cost science course which could be taught during the first 2 years of secondary school without the aid of qualified teachers and conventional laboratories. This teaching guide contains instructional strategies for exercises which consist essentially of observing and recording changes in the development of organisms. These exercises provide the practical background to concepts presented in the ZIM-SCI units E1 ("Life: Beginning and Growing") and E2 ("Reproducing by Flowers and Seeds"). Although methods to study the development of the frog, mosquito, housefly, bean, and maize are provided, similar methods may be applied to other organisms of choice (depending on time of year and organisms available in a given area). Since no student study guide accompanies this teaching guide, it is strongly recommended that unit be read before starting and that exercises be presented in the order in which they appear. (JN)

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ZIMBABWE SECONDARY SCHOOL SCIENCE PROJECT

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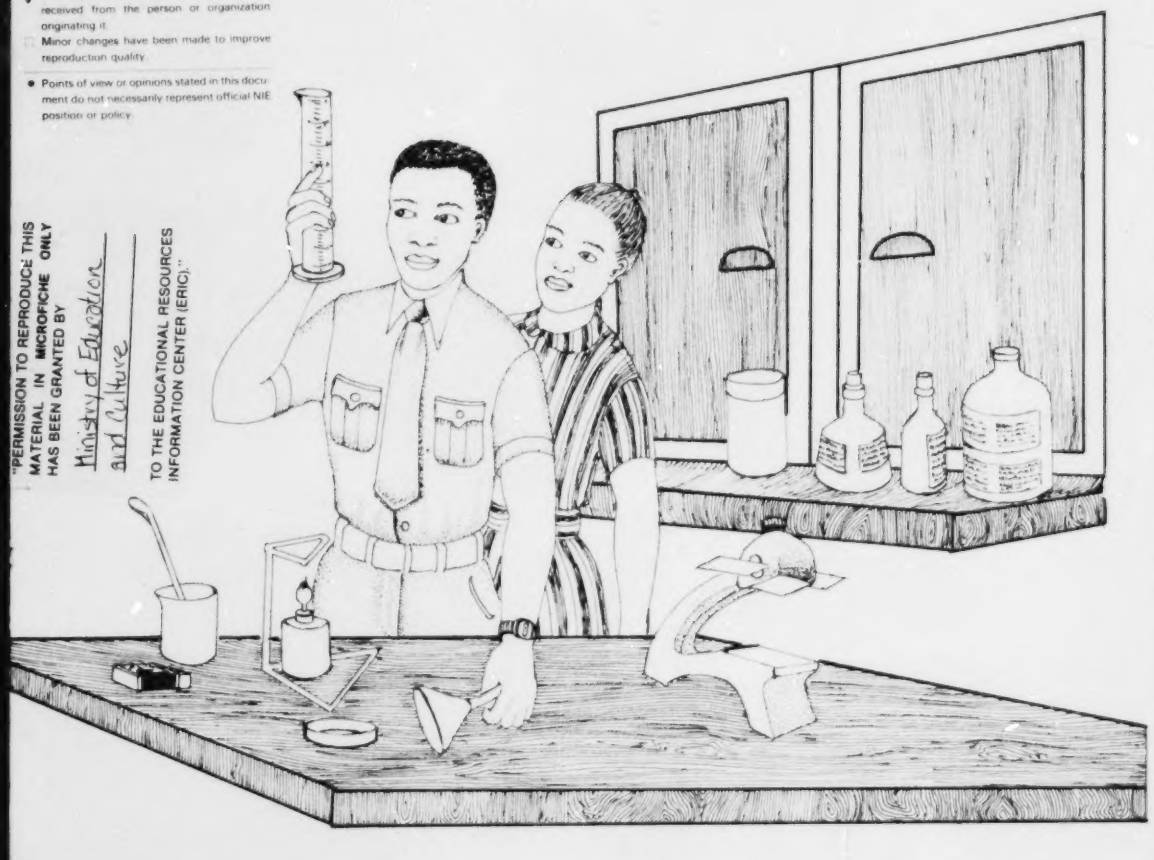

TEACHER'S GUIDE UNIT E3

Observing Some Life Cycles

SE 043 849

UNIVERSITY OF ZIMBABWE
AND MINISTRY OF EDUCATION AND CULTURE

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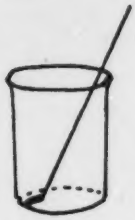
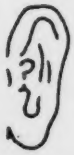
December, 1981.

The following symbols will be used to indicate the points in the lesson at which teacher activity is particularly important. These symbols also appear at the corresponding points in the pupil study guides.

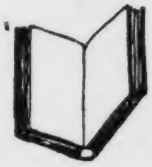


Practical work. The necessary instructions for each experiment will be given to you when you see this symbol.

Written exercises for the pupils. If possible these should be put on the blackboard before practical work begins so that the pupils can see what to look for.



Teacher information. The pupils will need extra guidance at these points. The information they will need from you is given where you see this symbol.



This symbol appears at a point where it is necessary for pupils to think over what they have done in the past few lessons. Set aside a period for this review activity. Encourage the pupils to read over their notes and the study guide section which they have just covered. It may be helpful to ask them to write a summary too.

The following symbols which appear only in the Teacher's Guide are used to indicate important points for you the teacher.

Take note of an important point.

This symbol indicates a preparation of apparatus which should be done well ahead of time. Please read these notes carefully and carry out the instructions well in advance.

We have placed this symbol next to experiments where we feel there may be a possible danger. Please read the section carefully so that you know about the particular danger in that experiment. It would also be wise to refresh your memory on the appropriate safety or first-aid procedures described in the Zim-Sci Handbook.

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AIMS OF UNIT E3

When pupils have completed this Unit they will be able to:

1. Describe the life cycles of selected organisms.

2. Construct and maintain a suitable habitat for selected organisms.

3. Construct a table of daily observations of a developing organism.

TEACHER'S GUIDE

This Unit is intended to run alongside Units E1 and E2 which are concerned with reproduction. The Unit provides the practical background to the concepts being developed in E1 and E2. There is no pupil study guide for this Unit and it is therefore important that you follow the guide closely. You should read the whole Unit before beginning Unit E1. The Unit should not entail a great deal of work for yourself once you have started it. However, it will require regular supervision.

As stated in the Aims, the pupils will be observing very closely the patterns of development of some plants and animals. The Unit will prove very exciting for you and the pupils. However, as most of the life cycles of these organisms take a long time, close and regular supervision will be essential or things will go wrong and interest will be lost.

The study consists essentially of observing the changes in the development of the organisms and recording these changes. No experiments will be carried out. A few minutes each day will be needed for pupils to care for their particular organisms, observe them and record any changes.

At least three organisms should be studied: a plant, an invertebrate and a vertebrate. Bearing in mind that the pupils have already learned about reproduction of the chicken and the human, no large animals need be studied in detail. Here is a list of plants and animals which may be studied. Other plants and animals common in your area may also be included.

Flowering plants

beans
peas
maize
tomatoes

Animals

Invertebrate:

mosquito
cockroach/locust/grasshopper
housefly
butterfly/moth

Vertebrate:

Lizard/ghekko
frog/toad
birds (chickens)
rabbits
mice

This guide gives you all the information you will need to help pupils study the development of the frog, mosquito, housefly, bean and maize. You may use a similar method for other organisms you choose to study. Your choice will depend on the time of year and what organisms are available in your area. For example, in the winter you could choose to study a bean or a tomato but NOT maize, a chicken or a cockroach but NOT a mosquito or a frog. (These are only available in the summer.)

The order in which you study the life cycles is not important. You can divide the class into groups and study all three at the same time if you wish. You are left to decide upon this and how to organise the class.

GENERAL POINTS

Preparation

Read all the information on the organism you intend to study before you begin. Prepare ahead of time where indicated. For example, if you decide to study the frog, try and find a place where you can obtain a pair of mating frogs or frogs eggs.

The Study

1. At the beginning of every section a few questions have been listed which may aid in the introductory discussion you hold with your pupils. The answers are given to you as a guide to assist in the discussion.
2. Before carrying out a study give the students the table shown at the beginning of the first section for them to copy in their books. Large, clearly labelled, diagrams should be drawn by pupils in recording their observations.
3. Often observations will have to be made on days when there is no science class. You must make arrangements with the class about the times when they will do this. Before school, breaktimes or lunchtimes are suitable.
4. All drawings must be made with the aid of hand-lenses, except in cases where you prepare a slide for the pupils to look at. For these slides pupils should be allowed to view the specimens under the microscope and copy a drawing which you have made on the board.

Since this is a series of observations we do not expect you to instruct the pupils during these observation times. In fact on non-science days, you may not even be present! However, we have included a list of important points which we hope pupils will notice for themselves. If you feel they are not observing well, perhaps you might find time to help them to notice these important points.

Linking with E1 and E2

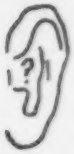
N. B.

Units E1 and E2 provide the theoretical and background information on reproduction. You will find many opportunities to link the pupils'observations with the more formal studies in E1 and E2.

SECTION 1

DEVELOPMENT OF THE FROG OR TOAD

These are some of the questions which you might use in your introductory discussion on the frog or toad.



1. What time of the year are frogs most commonly found?
   Answer: during the rainy season.
2. What time of the day are they most likely to be seen?
   Answer: in the evening and early morning.
3. What do you think happens to them during the dry season?
   Answer: they hide away in the ground and under stones for protection from the sun.
4. When do frogs or toads usually reproduce (breed)?
   Answer: during the rainy season.

Setting up a home for frogs

You will need:

- a baby bath
- sadza
- insects
- pond plants and algae
- chicken wire mesh
- sand, soil and some rocks

Pupils will need the following when they are making observations:

- handlens
- bioviewer and biomount
- lids of plastic beakers
- microscope

An Aquarium

An aquarium is an artificial pond and is usually temporary. It is also normally portable. Many water organisms, such as small fish, microscopic animals, water plants and tadpoles may be bred in an aquarium.

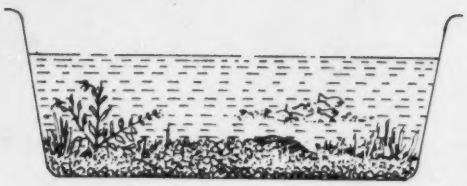
One of the baby baths provided may be used for establishing the aquarium. There are four main components of an aquarium. These are:

1. Some ground: this is a mixture of sand, soil and gravel in equal quantities on which water plants may grow.

2. Some water plants and algae: Water plants and algae (looks like green cotton wool) may have bilharzia carrying snails on them. To avoid getting bilharzia scoop the plant materials out of a river using one of your buckets or a badza. Wear plastic bags as gloves. Remove any snails from the plants in the bucket and then leave the plants there for two or three days before putting them into your baby bath.

3. Animals: tadpoles, small fish and so on.

4. Water: you do not need to change the water in the aquarium unless it becomes dirty and cloudy. This sometimes happens if you put in too much food which rots. The water may be changed with a beaker, leaving just enough water for the animals to be submerged. Fresh water can then be added. It is important to note that tadpoles, fish and most organisms for that matter will not survive in acidic conditions. These are usually brought about by decomposition of food and organisms. It is therefore important for you to make sure that all excess food and dead organisms be removed.



Feeding

Tadpoles eat plant materials (herbivorous) in their early developmental stages and later become meat eaters (carniverous). If algae is available they will eat it. They will also feed on raw mealie meal or small pieces of cooked sadza, or cereals. When the tadpoles are 5-6 weeks old you may begin feeding them with dead insects such as flies and grasshoppers which are soft bodied. Students may collect some of these with the insect catching nets they made in Unit A2.

P

Ponds

If there is no pond on your school grounds it is strongly recommended that you as the science teacher start a permanent pond which could be useful in science and beautify the grounds at the same time. This pond will be a valuable source of plant and animal specimens. Instructions on how to build a pond are provided

Building a pond

These are essentially the same as aquariums although they are normally fixed structures. Generally, a pond with a diameter of about 1.5-2m is sufficient, with a depth of about 0.5-0.75m. This size pond would be constructed with brick or concrete in a partly shady place in the school grounds. However, ponds have been constructed from barrels cut in half or in holes in the ground which have been lined with a large sheet of plastic.

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Pond water may stand for up to 2 years without water change.

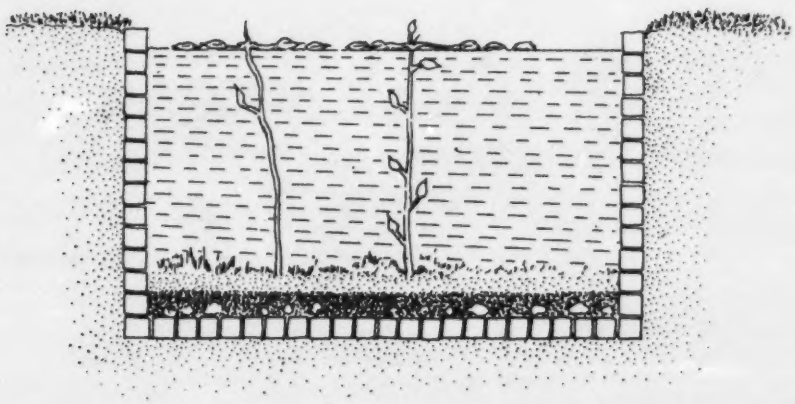
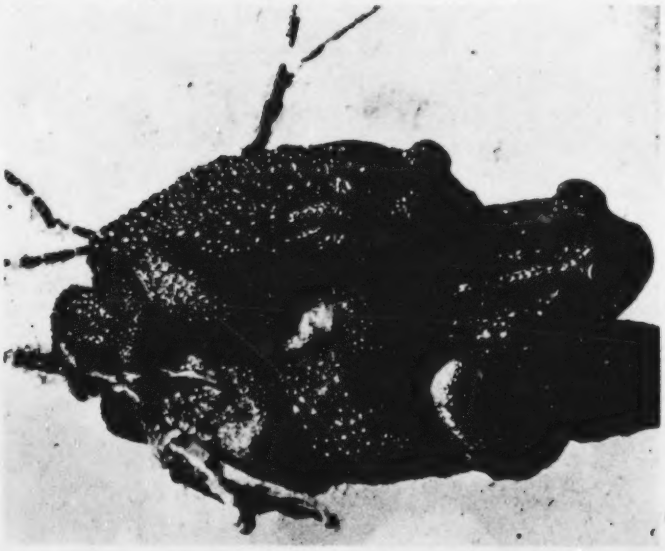


Table for students'note book

DATE	IMPORTANT CHANGES	DIAGRAM
Daily reading	These will be the pupils' actual observations. If they see no change, they should record "no change".	These should be drawn as large as possible from live specimens. They should only draw when a change is observed.

Stages in the life cycle

1. Mating: If you are able to find a pair of frogs or toads mating, bring them to the class and place them in the aquarium. They should continue mating in the aquarium. Below is a photograph showing toads mating.



Important points the pupils should notice:

(a) male (on top) is smaller than the female;
(b) they are not joined together;
(c) mating happens in the water;
(d) eggs come out of the female during mating.

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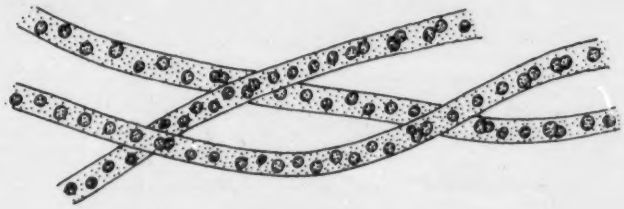
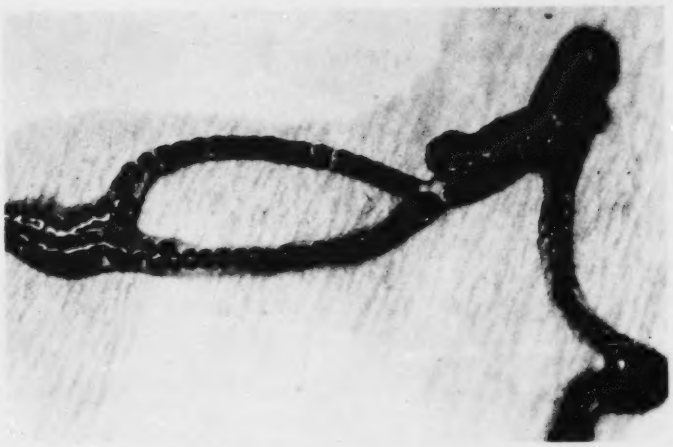
2. <u>The eggs</u>: You will find the eggs in still water, floating either in strings or in groups. They look like small black dots surrounded by a colourless jelly.





Provide your group of pupils with 3-4 eggs on a plastic beaker lid. Ask them to observe them with their handlenses and their bioviewers. Prepare micromounts by placing an egg or two on the acetate strip. Add a few drops of water and then carefully fold the strip over the eggs. <u>Do not squeeze these out of shape</u>.

Place a few eggs on a microscope slide, add a few drops of water. Do not cover the eggs with a coverslip. Observe the eggs under low power magnification.

Important points the pupils should notice:

(a) colourless jellylike fluid surrounding the egg;
(b) size of the eggs - use a ruler;
(c) the number of eggs - try to estimate.

3. The tadpole (newly hatched): After 2 days a tadpole should hatch from the eggs. Pupils should observe a tadpole on a beaker lid with their handlens. They must always add some water. Tadpoles should be handled very carefully and returned to the aquarium after observation.

Important points the pupils should notice:

(a) where most of the newly hatched tadpoles prefer to be (they cling on the water plants and the rocks with their mouths which act like suckers);
(b) the appearance of the tadpole - it is fishlike and has gills on the outside which are used for breathing (these can only be seen clearly in the first two days);
(c) they feed on pond plants, algae, sadza and small pieces of vegetables.

4. 6-8 day tadpoles: Observations with their handlens.

Important points for the pupils to notice:

(a) the external gills have disappeared;
(b) the tadpoles are about 5-6mm long;
(c) the tadpoles swim vigorously in the water.

5. 6 week old tadpoles: Observations with their handlens.

Important points for the pupils to notice:

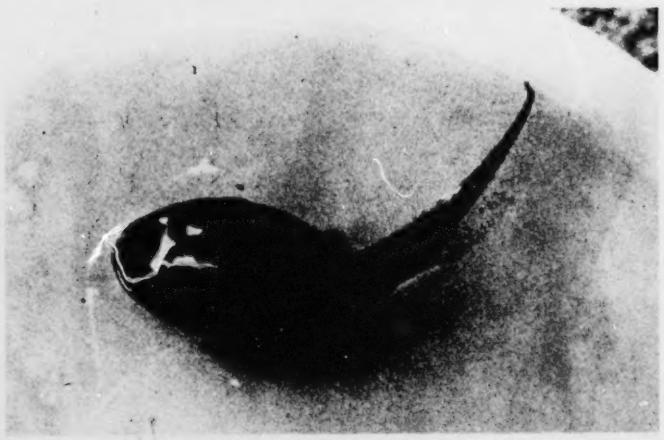
(a) the back (hind) legs have begun to develop from a small stump;

6. 9 week old tadpoles: Observations with the handlens.

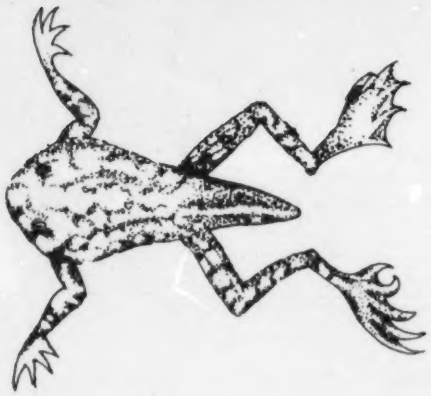
Important points for the pupils to notice:

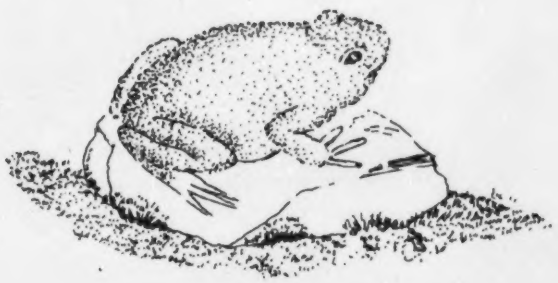
(a) the hind legs are fully developed;
(b) the fore (front) legs are developing.

Note: Tadpoles at this age are carnivorous and may be fed on dead flies, insects and raw meat or liver. It is also suggested that the number of tadpoles be reduced to about 30 at this stage. Put the extra tadpoles back in the stream.



7. Adult toad/frog (12 weeks):

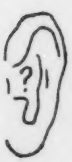




Important points for the pupils to notice:

(a) all four limbs are developed;
(b) the body shape has changed and the frog has adult features.

Further discussion:

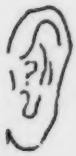


How long do you think a frog takes to be fully grown?
Answer: three years.
What else will it do in its life here?
Answer: it will find a mate and will reproduce young.
How much care do the parents give after the eggs are laid?
Answer: none - the parents only come together to mate, after that they leave the young to develop on their own.

SECTION 2

DEVELOPMENT OF A HOUSEFLY

Here are some questions you may use in your introductory discussion.



1. Where are houseflies most commonly seen?
   Answer: houseflies are often seen where there are decaying or rotting substances.
2. Is there a time of the year when they are more common?
   Answer: yes, in summer when the weather is warm and moist. They are less common in winter.
3. Why are flies harmful?
   Answer: they are responsible for distributing many human diseases, like cholera and diarrhoea.
4. How do you think they do so?
   Answer: the body of the housefly is quite hairy. These hairs carry germs and dirt from rubbish outside onto our food and our kitchen utensils.

Pupils'notebook

Pupils should prepare a table of their observations similar to that suggested for the frog.

Setting up

You will need:

- several small pieces of raw meat or fresh cow dung. (Try to use meat as the eggs are more easily seen)
- a jam jar
- handlens

When the weather is moist and warm, find a shady place in the garden and place several small pieces of raw meat or fresh dung on pieces of paper. Do not cover them. Before the end of the day the flies will have laid their eggs on the material in very small white clusters. Look for them with a handlens.

Note: one piece of meat will be sufficient for each group.

Send the pupils to the spot where the meat is placed so that they can see the flies sitting on the meat.

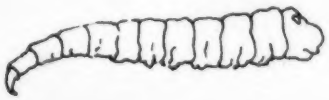
Stages in the life cycle

1. The Eggs: Ask the pupils to examine their piece of meat with the handlens and bioviewer to find eggs. After they have observed the eggs, transfer the piece of meat to a jam jar and cover it with a plastic bag with airholes. The plastic bag can be secured with a rubber band.

Important points the pupils should notice:

(a) colour of the eggs (white);
(b) shape of the eggs (oblong);
(c) length of each egg - use ruler (about 0.2 - 1.0mm long);
(d) estimated number of eggs (about 100 - 150 in a batch).

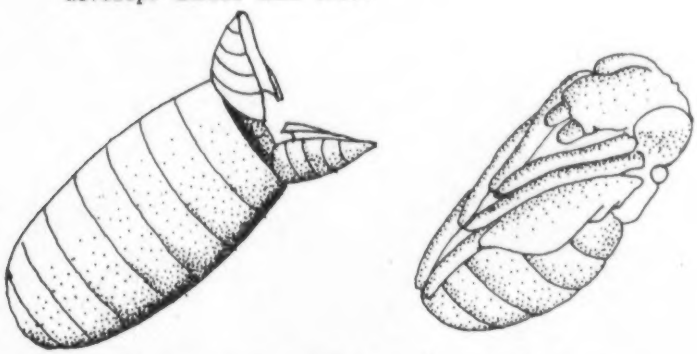
2. The Larva: after about 24 hours, a larva should hatch from the egg. Encourage the pupils to examine the larva through the sides of the jam jar with a handlens.



Important points the pupils should notice:

(a) length of larva (about 1cm long);
(b) resemblance of larva to a worm with a narrow end and a wider end;
(c) it obtains its food from the decaying substance.

3. The Pupa: five days after hatching, the larva moves to a drier place. Its skin hardens and turns brown to form a covering called a pupal case. A pupa develops inside this case.



If there are several pupae in a jar it will be interesting for pupils to cut one or two open at different ages (e.g. after five days and after ten days).

Important points the pupils should notice:

(a) oval shape of the pupal case;
(b) the immature housefly is undergoing many changes inside the pupal case.

4. The Adult Housefly:

Important points the pupils should notice:

(a) the adult was developing inside the pupal case;
(b) pupal case bursts open and adult comes out after about 1½ to 2 weeks.

Further Discussion:

These are some points which you may include in the discussion.

1. How long do you think a housefly lives for?
   Answer: about 3 weeks.

2. What must it do before it dies?
   Answer: it must mate and the female will lay her eggs on a rotting substance.

3. How much care did the female give the eggs and developing housefly?
   Answer: none. After laying her eggs she left them to develop on their own.

4. The importance of flies to man. Since flies are known to be responsible for distributing many human diseases it is important to find out how best to destroy them or prevent them from doing so.

   In the discussion ask pupils for suggested methods of destroying houseflies. Here are a few suggestions:

   (a) human and animal faeces must be disposed of so that flies cannot reach them, e.g. covering pit latrine holes

   (b) manure heaps must not be allowed to stand for long periods near houses. Because of the shortness of the fly's development time, turning over the manure heap or digging it in within two weeks prevents flies breeding.

   (c) food must always be covered;

   (d) insecticides can be used to spray places where flies may breed.

SECTION 3

DEVELOPMENT OF THE MOSQUITO

Discussion

1. What do we all know about mosquitoes?
   Answer: the painful bites and the malaria sickness that they spread.
2. When are mosquitoes most commonly found?
   Answer: in the wet season.
3. At what times of the day?
   Answer: in the evening and early morning.

Students Notebook

Pupils should prepare a table of their observations similar to that suggested for the frog.

The Study

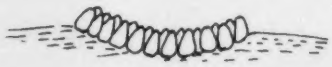
You will need:

ah aquarium or bucket
handlens

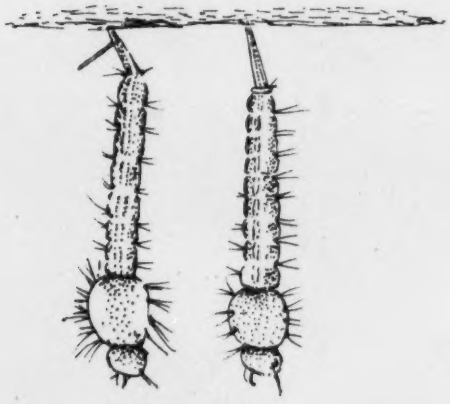
a jam jar
plastic bag with holes in it for a lid

Ask the pupils to collect water from tree stumps, tins and other places with still water. All this water can be put into one large basin or bucket. If there are no suitable sources of still water, put a tin of water out under a tree and leave it for a week or two.

1. The eggs: The eggs of the mosquito are very difficult to see as they are very small. In clear water they might be found. If you are lucky enough to find some put them on a slide for pupils to view.



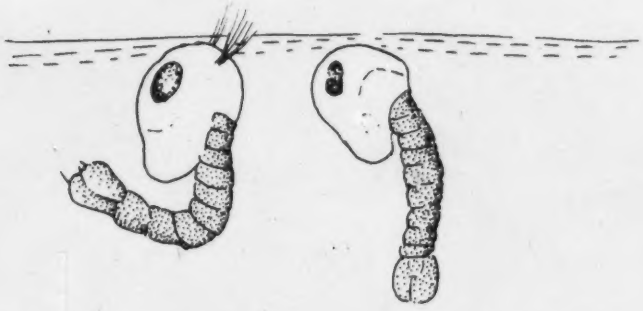
2. The larva: Within a day the larva escapes from the egg. The larva is easily seen on the surface of the water and should be transferred to a jam jar containing some water plants and water so that the rest of the life cycle can be observed.



Important points for the pupils to notice:

(a) the larva is a small wriggling animal like a caterpillar;
(b) it remains near the surface and it may attach itself to the plants in the water;
(c) it appears greenish after a few days because of the food it eats;
(d) clear characteristics of the larva - a distinct head, thorax and abdomen as in diagram.

3. The pupa: About 12 days after the eggs were collected, the larva should have become a pupa.



At this stage, cover the jar with a plastic bag with air holes. The plastic bag can be secured with a rubber band. This is to enable you to catch the adults that emerge.

Important points the pupils should notice:

(a) the pupa has a large rounded front (the head and thorax);
(b) the abdomen is narrow, curved and is segmented.

4. Adult Mosquito: about 2 weeks after the eggs are laid, an adult mosquito escapes from the pupa.

Important points the pupils should notice:

the adult mosquito comes out of the pupal skin by splitting it and climbing out.

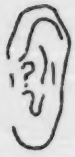
Further Discussion

1. What will the adult mosquito do before it dies?
   Answer: it will mate and the female will lay her eggs on water.

2. Does the mother mosquito care for her young?
   Answer: no.

3. What do adult mosquitoes feed on?
   Answer: the females usually feed on blood from humans and animals. The male usually sucks the juices of flowers and plants.

4. Have you any idea how malaria is caused?
   Answer: Malaria organisms live in the blood of a person sick with malaria. If a mosquito sucks blood from such a person it becomes infected. If the infected mosquito then bites a healthy person some of its saliva will mix with the healthy blood and that person may get malaria.



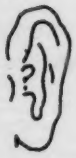
5. How do you think we can prevent ourselves from getting malaria?
   Answer: we could prevent the mosquito from biting us by:
   (a) using insecticides (drugs) to kill mosquitoes;
   (b) spraying chemicals on the water where mosquitoes breed, e.g. in ponds, drains, lakes;
   (c) removing containers which could hold water around the house;
   (d) using mosquito nets which prevent mosquitoes from biting us while we sleep;
   (e) treating people with medicines to cure them of malaria

SECTION 4

DEVELOPMENT OF THE COCKROACH

Here are some questions you may use in your introductory discussion.

1. What do we know about cockroaches?
   Answer: they are flat, brown insects which we do not like.



2. Where do we find them?
   Answer: in dark places, especially behind cupboards in kitchens where food may be found.
3. What sort of food do they like?
   Answer: the same sort that we do - sweets, sugar, cakes, fat and so on. They will eat paper, clothes or even shoes if there is no other food available.
4. Do we ever find them flying around?
   Answer: yes, at the beginning of summer, some fly around looking for a new home.

Pupils' Notebook

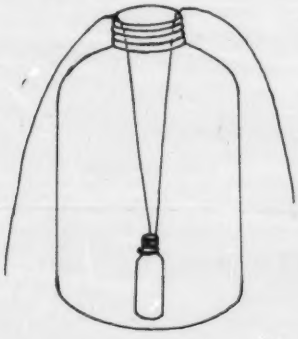
Pupils should prepare a table of their observations similar to that suggested for the frog.

The Study

You will need:

the large plastic bottle
a plastic bag
a brown paper bag
a rubber band
crumpled-up newspaper
one or two matchboxes
a small bottle
some cotton wool
some thread

Place the crumpled newspaper in the bottle. This provides a dark place for insects to hide in. Add one or two slightly opened matchboxes. Fill the small plastic bottle with water. Push a piece of cotton wool into the water, so that it acts as a wick for the insects to obtain moisture, without falling into the water and drowning.



Suspend this in the large bottle.
The bottle can be closed by covering the neck with the plastic bag and poking a few air holes in it using the mounted needle.
The bottle should be kept in a warm place, but not the direct sun. In the summer months, a corner of the classroom will do. Keep the bottle in a brown paper bag (to keep out the light).

Feeding

Cockroaches will eat almost anything, but are fond of pieces of cabbage, fat from meat, bread spread with margarine, sadza dipped in sugar and so on. These small pieces are attached to a piece of thread so that they can be renewed before they start to go rotten.

P

Obtaining Specimens

Cockroaches are not easy to catch as they run fast and hide away. A trap can be laid over-night on the kitchen floor near where food is kept. In a small box, very slightly open, place some cooked food. In the morning, close the box quickly and hope there will be a cockroach inside. Ask your pupils to try and obtain specimens for you. At the start of summer they may be found at night on the walls near a light.

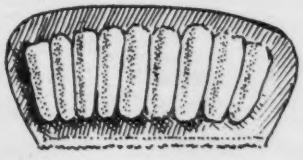
If you are lucky, you may find among the specimens one which seems to have an extra long body. This is likely to be a female which, having laid her eggs in an egg case is still carrying it around at the end of her abdomen. Put 6 to 8 cockroaches in the bottle. Put the bottle in the brown paper bag. When the pupils take it out of the bag they may be able to see the cockroaches before they hide away. If not, they can open the bottle top and, using a pair of tweezers, shake the newspaper (still in the bottle). The insects should fall out; and can be viewed through the bottle with the handlens.

If the newspaper is removed and opened out carefully in the baby bath the pupils may see the egg cases stuck to the paper, or some small newly hatched insects.

Important points for the pupils to notice:

1. The eggs:

   These are laid by the female in a small egg case - which is usually the same colour as the body of the mother. The female will carry this around, attached to her abdomen for 4 - 6 days. She will then stick it to some surface. The pupils should cut open an egg case to see the 2 rows of eggs inside.



2. The Nymph:

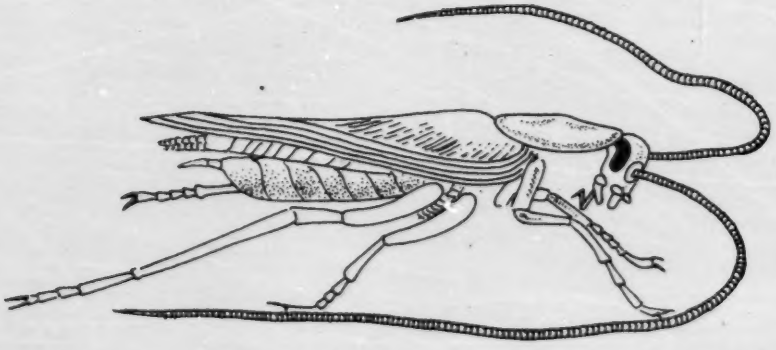
About 2 weeks after the eggs have been laid (8 - 10 days after the egg is deposited) the eggs will hatch and tiny, almost white, wingless cockroaches will emerge.

There are no larval and pupal stages. The insect increases in size by moulting, that is bursting out of its hard skin. It expands in size quickly before its covering hardens into a new hard external skeleton. This may happen 6 times before the insect reaches its full size. The pupils should watch for cast off skins or 'skeletons'. When they have removed the newspaper, they can clean the cage by shaking it out into the baby bath. Among the droppings there may be some cast off skeletons. These may be picked up carefully with tweezers, mounted on a biostrip and viewed under the bioviewer.

In some types of cockroach the adult female has no wings.

3. The adult cockroach

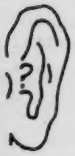
The body is very flat, so that it can crawl through narrow cracks to hide. As it lives in the dark, its eyes are not very useful, so it has long whip-like feelers to feel and smell its way around. It cleans its feelers by passing them through its mouth. The body is divided into the head, thorax and abdomen as in the diagram.



Further Discussion:

1. What will the adult cockroach do before it dies?
   Answer: it will mate and the female will lay her eggs in an egg case.

2. Does the mother cockroach care for her young?
   Answer: it provides some protection in the form of an egg case, but otherwise takes no care of the young.



3. What do cockroaches feed on?
   Answer: oil, left over food, even paper if food is not available.

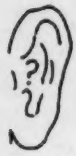
4. Are cockroaches useful to us?
   Answer: no, they are unwanted in that they feed on decaying food and live in our kitchens. They sometimes run over our plates, spoons or good food, leaving dirt behind which can cause sickness. Cockroaches can damage our shoes, books and clothing if there is not enough ordinary food for them to eat.

SECTION 5

DEVELOPMENT OF THE GRASSHOPPER

Here are some questions you may use in your introductory discussion.

1. Where are grasshoppers most commonly seen?
   Answer: in grasslands, farms and gardens.
2. What do grasshoppers feed on?
   Answer: green vegetation, i.e. leaves of plants and grass.



3. Is there a time of the year when they are more common?
   Answer: after the rains when there are lots of plant leaves available.
4. Of what importance are these grasshoppers?
   Answer: some people eat them as their source of protein, however, the grasshoppers in large numbers can destroy all vegetation.

Pupils' Notebook

Pupils should prepare a table of their observations similar to that suggested for the frog.

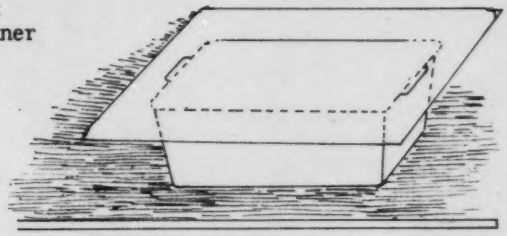
The Study

You will need:

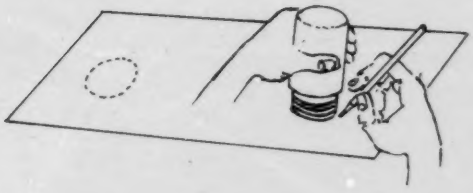
- a baby bath/asbestos trough/water bucket
- moist sand
- a few dry twigs
- live adult male and female grasshoppers
  (the female is larger than the male and has an ovipositor - see diagram)
- fine mesh wire (sieve wire) or clear plastic sheet to cover the open top of the bath/bucket/trough.
- 2 jam jars
- cardboard (e.g. the side of a packing box)
- scissors/scalpel

When you have collected everything proceed as follows:

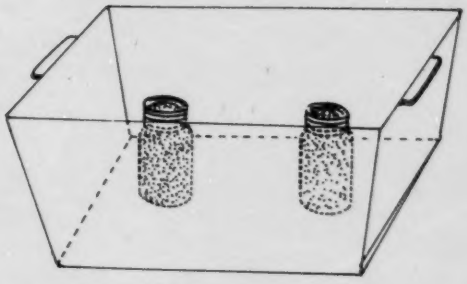
1. Cut the cardboard so that it fits inside the container



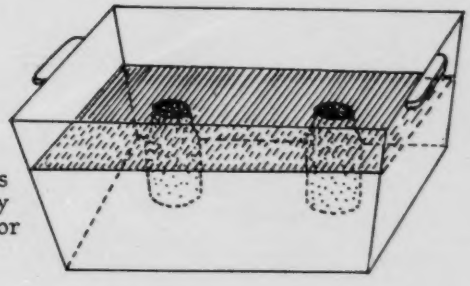
2. Place the cardboard on the table with the jam jar upside down on it near one end. Follow with a pencil the shape and size of the jam jar on the cardboard and cut out the traced circle to make a hole. Repeat to make another hole nearer the opposite end



3. Fill the jam jars with moist sand, level off the top and place them at the bottom of the container.

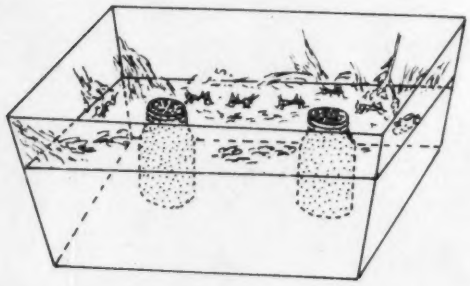


4. Now place the cardboard over the bottles so that the sand can be seen through the holes you have made. Put in the twigs for the insects to jump and play about on, and the fresh grass for them to eat.



Please turn over

5. Place the live adults in the container and then keep them from hopping out by putting either the sieve or clear plastic sheet securely on top.
(If clear plastic has been used - punch many small holes in it to let air in and out.)



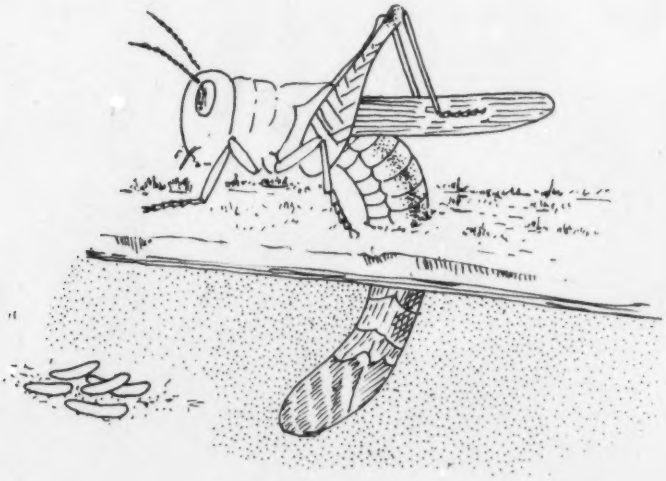
N.B.

1. Fresh green grass must be put in daily.
2. The optimum temperature for observing the developmental changes is 30°C. This warmth can be provided by shining a 40w bulb from above. If you have no electricity - keep the 'cage' you have made out in the sun. In this case changes take longer to be observed.

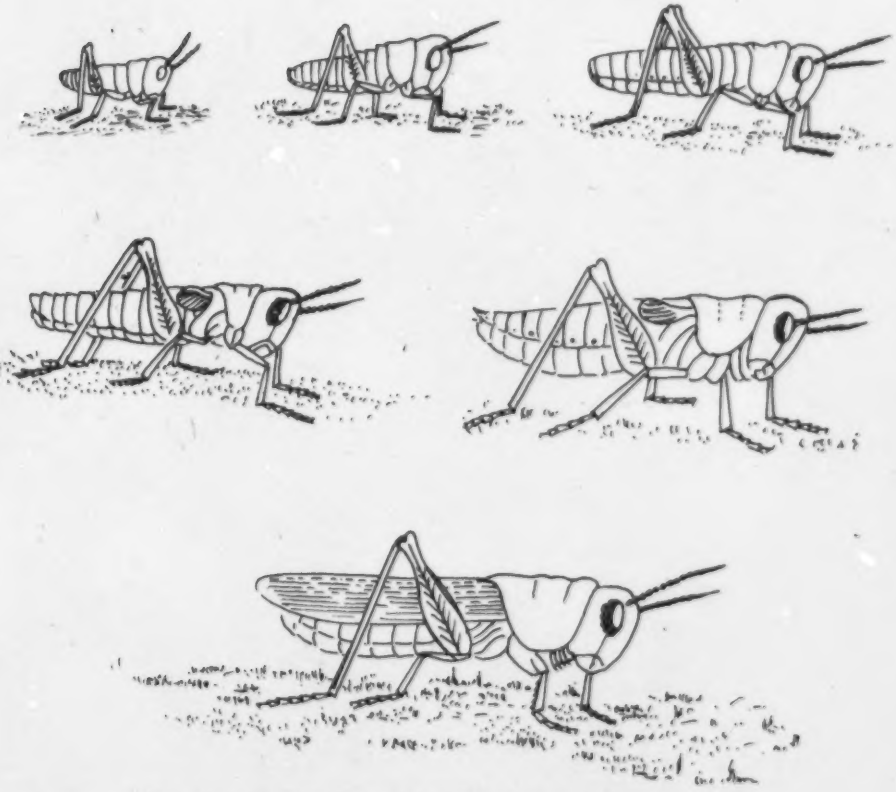
Stages in the Life Cycle

Important points the pupils should notice:

1. The adults mating.
2. The eggs: the female digging a hole using the tip of her abdomen. The female laying the eggs. The frothy egg casing (looks like a white patch on the bottle's sand surface). The children must look closely to observe this. It will be easier if the observation of the eggs and their protective case is done immediately after a female has been observed laying her eggs.
   The shape and colour of the eggs (separate them with a pin).
   The size of one egg (about 5mm long).
   How long the eggs take to hatch (about ten days or more at 30°C).



3. The Nymph: the egg hatches into an undeveloped wingless adult-looking grasshopper called a NYMPH.
The nymph's moulting, i.e. shedding off their skin which cannot stretch to accommodate the increasing size of the nymph as it grows and develops.



The amount of leaves eaten by the grasshoppers - and thus their potential for causing deforestation and creating a desert!
How long from egg laying to reaching adulthood (several weeks).

N.B.

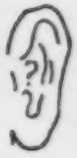
The adults can be kept for the class collection either pinned dry or in a mixture having 80% methylated spirits and 20% glycerine. This mixture is a good preservative because it keeps the insects soft for future studies.

SECTION 6

DEVELOPMENT OF A SEED

Discussion

Discuss with your pupils work covered in the primary school and in earlier units to find out how much they know about the structure and growth of plants. Questions you could ask might be:



1. Where does a seed come from?
   Answer: from an adult plant.
2. What does it need in order to grow?
   Answer: light, water, etc.
3. What will the seed grow into?
   Answer: another plant like its parent.

Students'Notebook

Pupils should prepare a table of their observations similar to that suggested for the frog.

The Study

Bean - preparation:

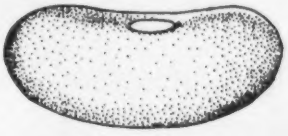
P

1. Soak about 40 bean seeds the night before planting.
2. Each group must fill a small plastic bag (about 15cm in diameter) with good soil.
3. Plant two soaked bean seeds into each plastic bag. Water the seeds regularly. Place the bags outside in a cool place.

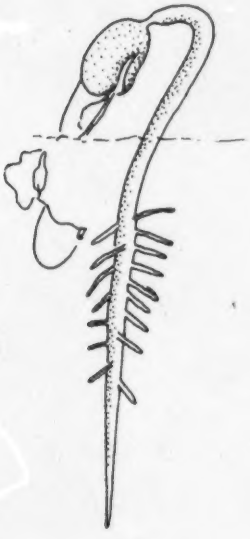
Observations:

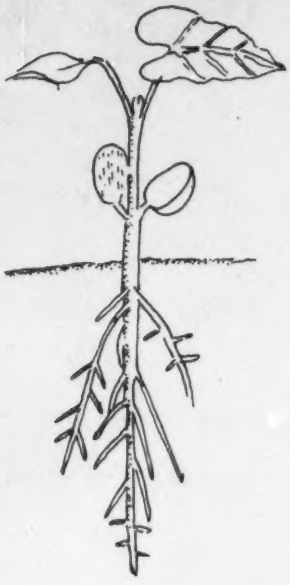
The seeds should be carefully observed and drawings and notes should be made to record the following stages:

1. Soaked bean seed.

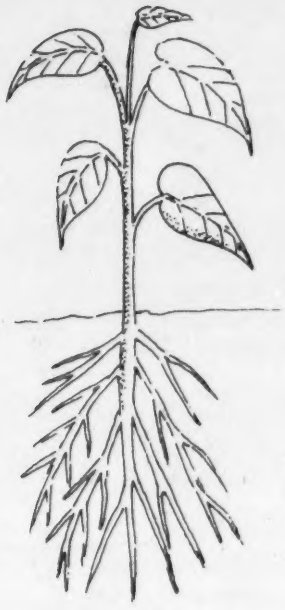


2. Cotyledons above the soil





3. The first leaves developing.



4. The plant growing to full size.

5. Bean flower.

6. Bean pod with seeds.

If there are a large number of successfully germinating bean plants, pupils might like to dig up one or two to observe the roots. For this reason, roots have been included in the diagrams.

P

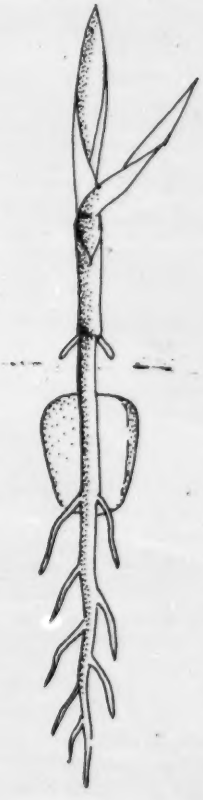
Maize - preparation:

1. Ask the pupils to till about $4m^2$ of land with a hoe.
2. Provide each group of students with 6 soaked maize seeds.
3. The students should plant these in rows. The students should water the plants regularly.

Observations:

Labelled drawings should be made of the following stages:

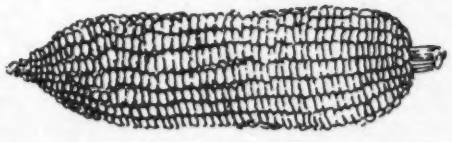
1. Soaked maize seed.



2. First leaves emerging from ground.
3. The plants growing to full size.

4. Flowers on maize plant. They should see two kinds of flowers.

5. Maize cob with seeds.



If there are a large number of successfully germinating maize plants, pupils might like to dig up one or two to observe the roots. For this reason, roots have been included in the diagrams.

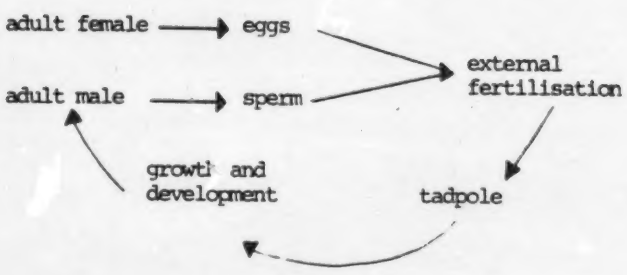
Linkage with E1 and E2

We hope you have, from the studies carried out by the children, provided many opportunities for linking E1 and E2 and illustrating the concepts discussed in those Units.

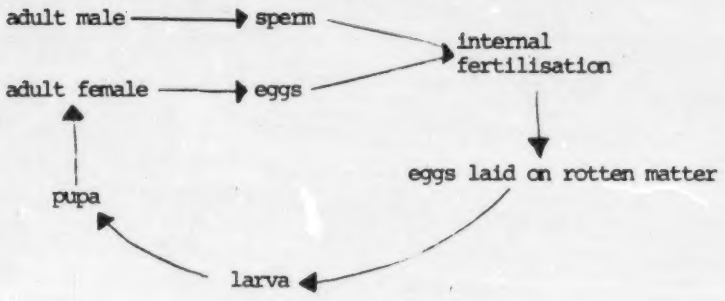
You should conclude these important studies (E1, E2 and E3) by discussing, and asking the pupils to draw, the individual life cycles of the organisms they have observed.

As a guide, here are the life cycles of the six organisms from which you have chosen examples for class observation.

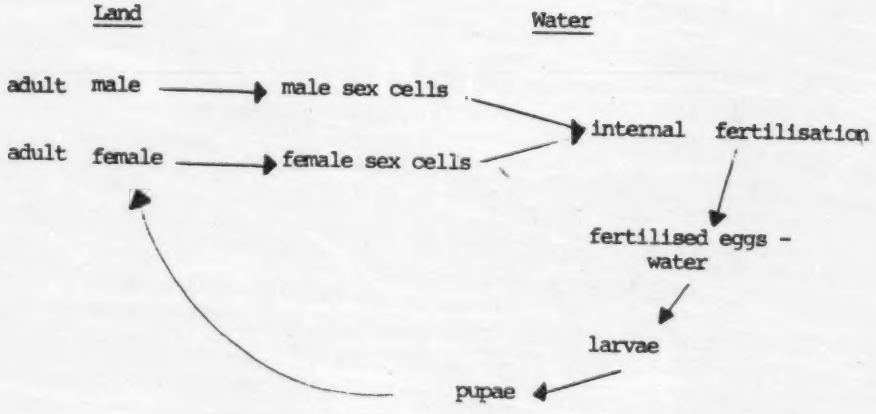
AMPHIBIAN LIFE CYCLE



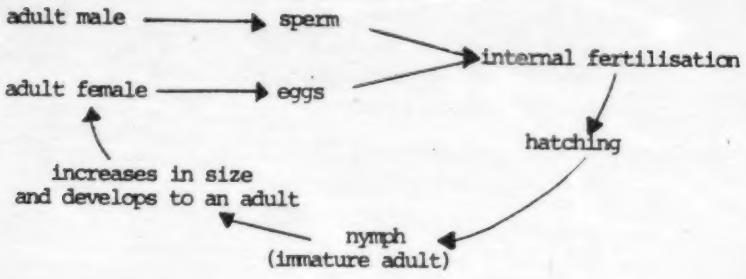
FLY LIFE CYCLE



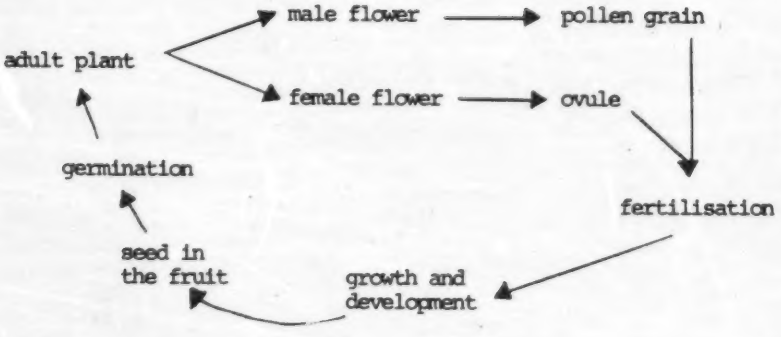
MOSQUITO LIFE CYCLE



COCKROACH/GRASSHOPPER LIFE CYCLE



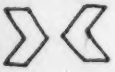
FLOWERING PLANT LIFE CYCLE



SUMMARY

1. All organisms follow a developmental life cycle with definite stages.

2. Some organisms hatch out of the egg as small, incomplete adults. Others show great differences in form between the egg and adult stages.



3. These stages can be fitted into a generalised life cycle.

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